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Cornell University School of Civil Engineering Tests on light beams of cold-formed steel

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(Transcript with emendations by Milton Male)

SCHOOL OF CIVIL ENGINEERING, CORNELL UNIVERSITY
TESTS ON LIGHT BEAMS OF COLD-FORMED STEEL
FOR THE AMERICAN IRON AND STEEL INSTITUTE

FIRST PROGRESS REPORT, MARCH 25, 1939

I. GENERAL STATEMENT

The investigation of light weight beams of cold-formed steel has been undertaken as a joint cooperation of the American Iron and Steel Institute and the School of Civil Engineering, Cornell University.

This investigation will consist of experimental studies on cold-formed steel beams as fabricated and supplied by the Institute.

II. IDENTIFICATION OF SPECIMENS

In order to systematize a nomenclature for the identification of test specimens investigated under the project we are using the following: Each specimen will be designated by symbols and figures, for example, A-14-64a in which;

A designates a series or type of cross-section,
14 designates the gage of material,
6 designates the depth of cross-section,
4 designates the width of bottom flange,
a designates particular beams if duplicates are submitted.

III. OBJECT OF WORK TO DATE

An abbreviated set of tests were carried out on those sections with the narrowest (A-14-64a) and widest (A-14-612a and b) tension flanges, in order to obtain preliminary information as a guide for future investigation.

IV. THEORETICAL COMPUTATIONS

Theoretical analyses of these sections were carried out using an assumed Young's modulus equal to 29,500,000 lbs. per sq. in. The ideal dimensions of each cross-section were used in evaluating the modulus of inertia (I) and the section modulus (S).

TABLE I. THEORETICAL COMPUTATIONS

Specimen	Moment of Inertia (I)	Section Modulus (S)
A-14-64	7.82 $in.^4$	2.607 in^3
A-14-612	18.75 "	6.175 in^3

The value of stress and deflection computed from these ideal values will be designated hereafter by the the subscript t (theoretical).

V. DIMENSIONS OF SPECIMENS SUBMITTED IN SERIES A

Cross-sections of all specimens vary considerably from the ideal both in linear dimension and form. Of particular note is the fact that the tension flange was not at right angles to the web. Actual dimensions for typical cross-sections are shown in Figure 1. The cross-sections shown are those at which experimental stress determinations were made. Variation from the ideal of the same order of magnitude were observed throughout the length of the specimen.

VI. METHOD OF TESTS

Beams were mounted as shown in the accompanying photograph.* Reactions were accomplished through rockers and the quarter-point loads were applied through rollers acting through knife edges. The load was applied in successive increments until a stress of approximately 20,000 lbs. per square inch was realized in the flanges. A telescope was used to determine the deflection of the neutral axis of the center of the specimen with reference to a fiduciary mark fixed to the reactions.

Four one inch Huggenberger tensometers were mounted on both sides of the tension flanges and symmetrical to the web. See Figure 2. Only longitudinal strains were observed in this preliminary test. Two values of the distance x were chosen, i.e., a minimum and a maximum value permitted by the characteristics of the tensometer mountings and by the width of the flange, respectively. The instrumentation was carefully considered in order to prevent the introduction of extraneous stresses.

The photographs show a beam mounted in the testing machine. Sufficient copies not available for distribution.

IX. CONCLUSIONS

1. Variation of both stresses and deflections from the theoretical apparently is caused by deviation of the cross-section dimensions and of the symmetry from the ideal section.

2. Correlation of the deviations from the ideal with variations in the dimensions of the specimens is given in Table III.

TABLE III

Specimen	Stress		Difference	Difference in area of tension flange	
	Theoretical	Actual		Amount	From
A-14-64a	13820	14450	+ 5 percent	10 percent	ideal
A-14-612a	14580	12950	-12 "	11 "	each other
A-14-612b	14580	14450	- 1 "		

The dimensions of specimens A-14-612a and b differ so greatly from the ideal that a comparison of the theoretical and actual stress is of little value; hence the stresses in this beam were compared with one another to show that variation in cross-section in this pair would account for the differences shown in Table III. It is apparent that the experimental observations are in agreement with theory.

3. The longitudinal stress in the tension flange of specimen A-14-64a was 5.2% less at the outer edge than near the web (refer to Table II). This result likely is due to the bent-up initial condition resulting in a smaller distance from the neutral axis to the outer part of the flange. Likewise a 13% variation of longitudinal stress across the tension flange was observed in both specimens A-14-612a and b but in this case stress was greater at the edge. These flanges were originally bent down.

4. Stresses across the tension flange increase with distance from web if the flange initially is bent downward and decreases if the flange is initially bent upward. As these variations are of the same order of magnitude as distance from the neutral axis we may conclude that the width of the flange of this series of specimens does not result in a reduction of the effective section.

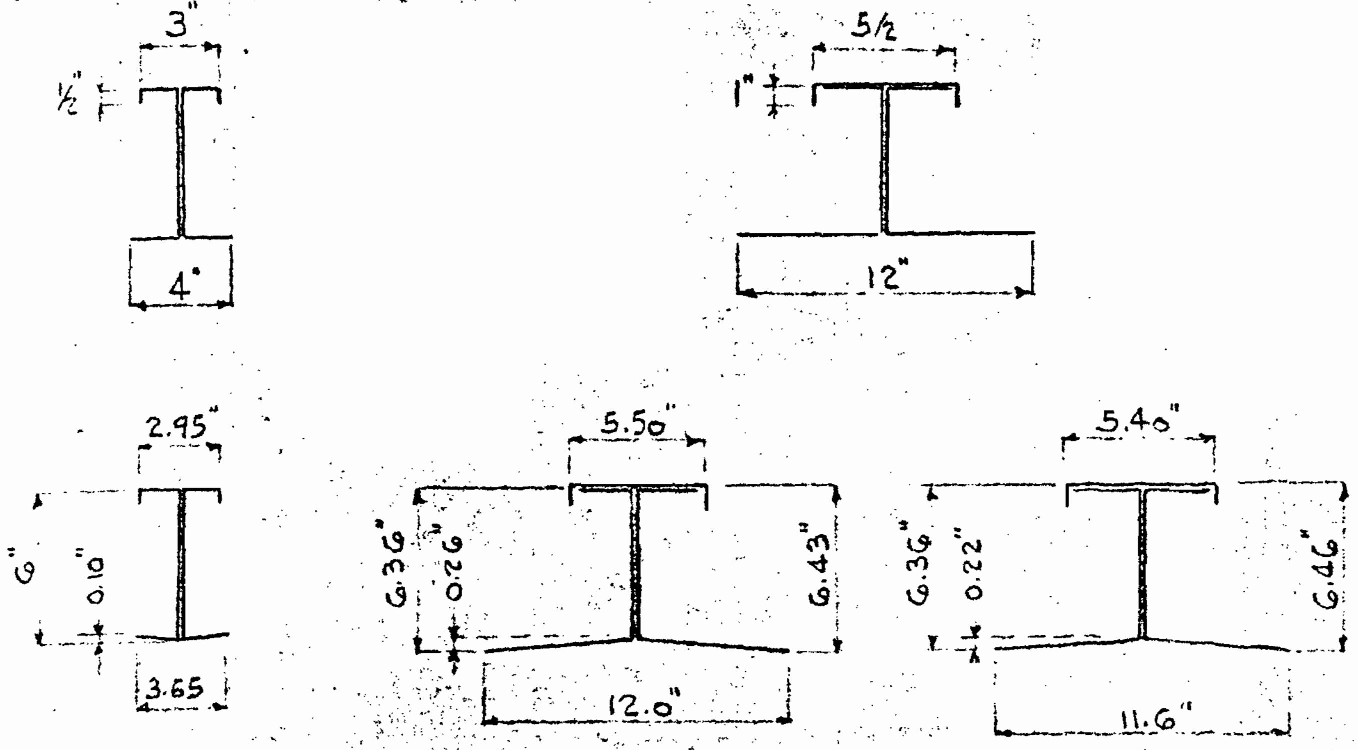
X. SUGGESTIONS

1. Beams of 8" depth are necessary in order to accommodate the 1/2" Huggenberger tensometers required for accurate lateral strain measurements.

2. The above tests show that variation in dimension and form cause considerable deviation in stresses both from the ideal and the mean. The fabrication of the specimen so that the flanges are perpendicular to the web is of especial importance.

3. Future collateral material for tension tests should be 6' long and 2' wide.

4. Since no decrease in the effective section was observed for the present series, we suggest that the next set of specimens be of the thinnest gage contemplated for such tests.



STEEL THICKNESS

cimen Mark	A-14-64a	A-14-612a	A-14-612b
age	0.0755"	0.0795"	0.0756"
er X-Section		0.0795"	0.0742"
iation		± 0.002"	± 0.0005"

FIG. 1

DIMENSIONS OF BEAM SPECIMENS

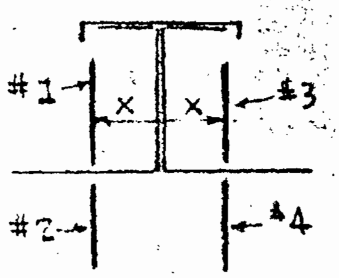


FIG. 2

LOCATION OF GAGES